EFFECTS OF ZERANOL IMPLANTS ON WEIGHT GAIN IN LARGE AND SMALL FRAME PREWEANING STEER CALVES

by

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Introduction

The profit potential of the cow/calf segment of the beef industry is dictated by efficiency of production. Many cattleman feel they are already producing beef as efficiently as possible, but the National Cattlemans Association (NCA) report (1982) showed that most can further improve performance by using technology currently available. Records of Agricultural lenders indicate wide variation in efficiency and cost of production with the cost per hundred weight of calf for the least efficient producers being double the cost of the most efficient operator (Cain, 1985).

Promoting growth with zeranol implants has become an important part of beef production and has withstood the test of time since first introduced in 1969. Without a doubt, the most cost effective management practice which can be employed is implanting (Cain, 1985). Implanting with zeranol is relatively inexpensive and has been shown to return producers up to $20.00 in increased gains and/or improved feed efficiency for each dollar invested. The response to zeranol (active ingredient in Ralgro) is documented by numerous research trials that clearly demonstrate the economic advantage of incorporating growth promotants into any beef management program (Corah et al., 1976). Also, vital safety data has been generated to insure that beef from cattle implanted with zeranol is safe for human consumption (Martin, 1984).

Producers understand the economic benefits of increased live weight gain (KilKenney and Sutherland, 1970). Preweaning calf performance is especially important due to the rapid growth potential during the suckling period. This is when calves make the most efficient gains, because of rapid development in the major tissues of bone and muscle.

In the beef industry, there is great variation in the frame size and type of cattle being produced. Within individual beef breeds, feeder cattle are being produced ranging from small types that mature at light weights to large types that mature at heavy weights. Different growth rates of these large and small frame cattle may influence their response to implants. During growth, the proportion of protein and fat deposition will vary depending upon such factors as weight, frame size, type, use of growth stimulants and nutrition (Fox and Black, 1984).

Differences in frame type is genetically determined, but basic physiological factors that regulate growth and development of various cattle types are not completely understood. Zeranol is an anabolic agent that exerts a positive influence on protein metabolism. This influence will enhance retention of nitrogen (protein deposition) and promote skeletal growth without increased deposition of fat.

The purpose of this study was to determine the effect of a 36 mg Ralgro implant on preweaning weight gain of small or large frame steer calf types.

Review Of Literature

What is Zeranol?

Zeranol is the active ingredient for the brandname growth-promoting implant (Ralgro) made and marketed by the Veterinary Products Division of International Mineral and Chemical Corporation (IMC). The implant is approved for use in steers and heifers from birth through finishing. The implants stimulate anabolic growth when placed under the skin at the base of the ear for slow absorption into the blood (Martin, 1984).

Zeranol is made by a multistep fermentation process from zearalenone, a natural metabolite of the mold Gibberalla zeae which was first isolated from maize grains in the United States. Zeranol is a crystalline chemical compound belonging to a class of natural products called resorcylic acid lactones and is not classed as an estrogen. However, it has a structure and configuration similar to some synthetic estrogens (i.e., stilbene) and is known to have estrogenic properties (Beverly, 1984). Zeranol, as does estrogens, appears to alter the secretion rate of endogenous anabolic hormones. Further identity of zeranol with estrogen has been demonstrated through its in vitro affinity for estrogen receptor sites (Beverly, 1984).

Anabolic growth promotants or agents are commonly divided into two classes; estrogenic or androgenic based on their overall effects on metabolism (Buttery et al., 1978). Estrogens are the major class used for ruminants (Muir, 1985) and have been shown to increase daily gain and feed efficiency from 10-20% in growing and finishing animals (Preston, 1975; Heitzam et al., 1980; Muir, 1985). However, estrogens are not anabolic for swine and cause increased fattening in poultry (Trenkle, 1969).

Over 150 derivations of zearalenone have been prepared and screened for biological activity (Brown, 1980), however the most active of these is zeranol. It was approved by the Food and Drug Administration (FDA) in November, 1969 for use as an anabolic agent in feedlot steers. For suckled calves, weaning calves, stored cattle, fattening heifers and lambs (except breeding replacements) approval was given in August, 1970. Recommended dosage is one 36 mg subcutaneous implant, which must be given at least 65 days prior to slaughter in beef cattle and 42 days in sheep and lambs where a 12 mg implant is used (Corah, 1984).

Mode of Action of Exogenous Growth Promoting Compounds

Zeranol has consistently been shown to enhance daily gain and feed efficiency in ruminants (Laudert et al., 1980). However, studies on mode of action have been less numerous and speculative at best. Trenkle and Burroughs (1978) have proposed four possible mechanisms by which growth may be enhanced: 1) increased production of androgens from adrenal cortex, 2) increased thyroid activity, 3) increased growth hormone (GH) secretion and 4) a direct effect at tissue level.

In common with estrogenic promoters, androgenic substances promote nitrogen retention. This has been demonstrated in heifers (Heitzman and Chan, 1975) and steers (Heitzman et al., 1977). Trenbolone acetate, an androgen, produces a reduction in overall rate of protein turnover (Buttery et al., 1978). This was consistent with the improved feed efficiency noted by (Heitzman and Chan, 1974). Zeranol and various estrogens have increased both adrenal weight and adrenocorticotrophic hormone (ACTH) secretory cell number (Wiggins et al., 1976). Hutcheson and Preston (1971) reported increased growth of androgen sensitive secondary-sex glands of castrate males which provide evidence of adrenal androgen secretion. Whether the adrenal corticosteriod

production is increased directly by the estrogenic compound or if it results from increased ACTH production is not known (Beverly, 1984). It is possible that androgens act indirectly by regulating the circulating levels of thyroxine. These proposed modes of action involving increased androgen production requires further investigation.

Zeranol has increased pituitary weights, thyroid weights and secretory activity in lambs and steers (Borger et al., 1973a; Wiggins et al., 1976). However, Rothenbacker et al. (1975) and Wiggins et al. (1979) reported depressed thyroid secretory activity and decreased thyroxine concentrations in lambs. Thyroid hormones (TH) significantly influence protein metabolism; and the response is dependent on dose rate. There is an optimal level of thyroid secretion for growth and metabolism which lies within a narrow range (Beverly, 1984). The author suggests that stimulations of thyroid activity might exceed secretory limits, resulting in depressed growth. Hyperthyroidism is associated with muscle wasting and the muscle protein degradation is reduced following thyroidectomy (Brown et al., 1981). Implanting with zeranol increases thyroid weights but secretory activity may be reduced (Rhind et al., 1984). Perhaps changes in thyroid activity partially explain the mode of action for zeranol.

It has long been recognized that GH is a critical and important factor in normal growth. Growth hormone is known to increase amino acid uptake by muscle, increase protein synthesis and nitrogen retention (Beverly, 1984). Increased GH section is the most widely accepted theory for exogenous estrogenic compound activity. Beverly (1984) proposed three possible modes by which zeranol enhances GH levels. These include: 1) directly stimulating release of GH from the pituitary, 2) stimulating hypothalamic release of GH releasing factors or inhibiting somatostatin, thus allowing secretion of GH

and insulin and 3) stimulating GH release which enhances somatomedin status in the body.

Preston (1975) has reviewed several modes of GH action, but concluded that the most plausible was that estrogen causes release of GH releasing factors from the hypothalamus. This in turn causes an immediate effect on the release of GH from the pituitary, resulting in increased growth and nitrogen retention (Machlin, 1976). The anterior pituitary has the ability to produce and secrete increased GH, as evidenced by its increased size (Trenkle, 1975), cell numbers, and especially an increase in the acidophilic cells where GH is thought to be produced (Preston, 1975). Trenkle (1975) agrees but adds that increased glucose levels lead to increased insulin levels in the blood plasma. Both GH and insulin stimulate tissue deposition.

Improved nitrogen balance has been attributed to increased plasma GH concentration on pituitary weights of zeranol-treated ruminants (Wiggins et al., 1976; Olsen et al., 1977; Trenkle & Burroughs, 1978; Beverly, 1984). However, Buttery et al. (1978) suggested that the increase in growth is achieved by a different mechanism than GH. Their work indicates zeranol actually decreased the rate of protein synthesis with the net effect of zeranol being increased protein accretion. However, the majority of the earlier evidence suggests the increased growth in zeranol-treated animals is in response to elevated GH levels. Trenkle and Burroughs (1978) suggest that it might also indicate a decreased metabolic clearance rather than an increased secretory rate of GH. Considering the relationship among GH, insulin and growth, Preston (1975) suggested that increased insulin might be responsible for the anabolic actions by stimulating protein synthesis.

Estogen receptors have been found in rat skeletal muscle (Knudsen & Max, 1980). This suggests that estrogens may elicit their action directly at the

tissue level. Buttery et al. (1978) suggested that the direct tissue action may be the result of estrogens competing with glucocorticoids (GLC) receptors, thereby blocking the GLC protein-catabolic activity. With continued investigation on the endocrine system; the mode of action of anabolic agents can be better understood.

Site of Implant

There has been renewed interest in the proper implant location for zeranol. The traditional implant location was inserted subcutaneous approximately one inch from the base on the backside of the ear (Brown, 1983). An alternative site for zeranol implantation received clearance in April, 1982. IMC began researching the potential change of site in 1980 (Wyatt, 1983). To implant zeranol in the alternate location, the needle should penetrate the skin just over the ring of cartilage at the base of the ear. Then insert the implant subcutaneously toward the head in the "pocket" of loose skin. This places the implant below the major blood vessels, into the fat muscle attachment of the ear, in a spot which facilitates proper absorption and efficient use of the implant (Wyatt, 1983). Since zeranol is a fat soluble anabolic agent, a location comprised mainly of adipose tissue should result in a greater and more efficient absorption process (DeWees, 1980).

The alternate implant site provides a more consistent improvement in weight gain response because implanting errors have been reduced (Plegge & Corah, 1979; Brown, 1983; Wyatt, 1983). The skin at this location is loose and can easily be picked up with your fingers allowing light weight cattle to be implanted without the aid of a headgate.

In research done by Plegge and Corah (1979), three studies were conducted to determine the effect of zeranol implant location and crushing on

observable side effects and growth rate. The four treatments used were (1) non-crushed traditional location, (2) crushed-traditional location, (3) non-crushed alternate location, and (4) crushed-alternate location. Implanting at the alternate location or crushing of pellets did not appear to cause side effects. Crushing of the pellets had no affect on animal performance. However, implanting at the alternate location resulted in a significant (6.6%) improvement in average daily gain in all three trials.

Plegge and Corah (1979) summarized the literature available on implant site. That summary indicates an average additional improvement in gain of 2.7% when the alternate deep site implant location is used. There is not as much data regarding feed intake and efficiency but limited data appears to indicate a 1 to 3% improvement in efficiency of feed utilization.

Implant Dosage

The amount of zeranol needed to provide maximum growth stimulation has not been demonstrated. Thomas and Armitage (1970) found no significant differences between the gain of steers that were implanted with 36 or 72 mg zeranol. These steers were wintered in Montana on a diet containing a moderate level of energy. Parker et al. (1979) studied levels of zeranol implants by conducting a 150 day trial with five treatments: (1) no implant, (2) 36 mg on day 56, (3) 36 mg on day one, (4) 36 mg on day one and 56, (5) 72 mg on day one. It was concluded that implanting with a growth stimulant is of little value unless the gains are in excess of 0.75 lbs/day. Further, this data indicates that one zeranol implant of 36 mg at the beginning of a 150 day feeding period was the most beneficial.

A study of dosage level with zeranol implants in suckling calves, was reported by Virginia workers, McClure et al. (1979), in which calves were implanted at birth and 10 days later with either 0, 12, 24 or 36 mg zeranol.

There was no advantage to using lower levels of zeranol to implant suckling calves since the 36 mg level produced a higher daily gain from birth to weaning than the other treatments.

Response to Zeranol

It has been shown that zeranol increases weight gain in cattle. Research has shown that steer calves, whether in the suckling, growing or finishing phase, will respond to an implant (Laudert et al., 1980).

Horn et al. (1976) reported that steer calves with an average age of 71 days and implanted with 36 mg of zeranol had increased weaning weights of 14.2 kg. Borger et al. (1973b) used 36 steers divided into six lots, to evaluate the effects of zeranol. Three of the lots were implanted with 36 mg of zeranol on day one and 84 of the 169 day feeding trial. Implanted calves gained 7.8% faster than controls (non-implanted). Daily gain of implanted steers was improved 4.3% over controls by day 56 and 8.5% by day 84.

Heifers in the suckling, growing and finishing phase also show a response to implants. Horn et al. (1976) reported that heifers implanted with 36 mg zeranol had an increased weaning weight of 10.9 kg over non-implanted controls. Zeranol implants have not, however, been recommended for use on cattle that are being kept for breeding. Nelson et al. (1972) exposed non-implanted and zeranol and Diethylslilbertrol (DES) implanted heifers to bulls to determine the effects of implants on reproduction. In a comparison of the four treatments: 1) control, 2) 36 mg zeranol, 3) 72 mg zeranol, 4) 24 mg DES; the control group had the highest percent declared pregnant and the 72 mg zeranol group had the lowest percentage pregnant with the other two treatments ranked intermediate. They concluded that the use of zeranol and DES implants on heifers would be detrimental to their reproductive performances.

Early research indicated few if any reproductive problems in heifer calves implanted prior to weaning with zeranol; however, recent data indicates some reduction in fertility as yearlings if the implant was given at birth (Simms et al., 1982). This same reduction in fertility as yearlings was also cited in a Missouri study (Morrow, et al., 1983).

Considerable research has been conducted on the use of zeranol implants in beef bulls intended for slaughter. Bulls to be used in breeding programs should definitely not be implanted because of inadequate testicular development, smaller scrotal circumference and reduced reproductive proficiency (Corah et al., 1979). Bulls being fed for slaughter respond less to implants than steers with similar genetic background. There is evidence that implanting young bulls every 100 days from near birth to slaughter results in lower carcass masculinity scores. Implanting bulls to improve palatability or tenderness of the meat has produced conflicting results regarding carcass composition (Unruh et al., 1983).

In examining the response to implants for all classes of cattle, it is necessary to consider the amount of live weight gain and feed consumed. Response may be influenced by factors such as cattle type, gut fill at weighings, feed conversion efficiences and the intervals between implantation.

Level of Usage

Surveys indicate that 55% of United States cattle producers are currently using implants (Cain, 1985), 34% never used implants, and 11% were classified as former users. Results were further divided into types of cattle operations: 1) cow/calf herds had 46% current users, 43% never used and 12% former users; 2) stocker-growers had 61% current users, 26% never used and 13% former users; 3) farmer feeders were intermediate with 58% current users, 33% never used and 9% former users.

This market survey data indicated that many factors may influence the management practices of cattle producers such as type and size of operation, full or part time status, age, level of education and percent of gross receipts obtained from the particular enterprise. An average United States cattle producer processes cattle twice during the ownership period. Furthermore, once a particular management practice is adopted, producers tend to incorporate other procedures into their program. Consequently, it is time for relevent comprehensive and innovative producer education programs that have the flexibility and creativity to appeal to these various producer backgrounds (NCA, 1982).

Simms (1986) conducted a Cowherd Survey Summary in Northwest Kansas. Total number of cows involved were 24,359 head. Cow-calf producers implanted 88.4% of their steer calves, 38.6% of heifer calves and reimplanted 30.3% steer calves. These results differ substantially from those of Armstrong (1980) who found only 12% of Saskatchewan calves were implanted while on the cow.

An extensive survey was conducted (Riley, 1983) of producers representing 60% of the fed cattle marketed in Kansas. Implanting was done in 100% of the feedlots with over 2,000 head capacity. In feedlots under 10,000 capacity, zeranol was used more frequently than other growth stimulants.

Those referred to as stocker operators, or those that purchase or raise cattle for grazing on pasture or range in Kansas during the summer months, reported zeranol was used by 88.5% of the producers.

Effects of Re-implantation

The National Agricultural Advisory Service conducted some of the earliest experiments in the 1950's on the effect of re-implantation with

hexoestrol. In a later trial conducted by Everitt (1962), repeat implants of hexoestrol at 30 mg did not support the increased growth rate obtained with a single dose of 30 mg. A double dose of 45 mg tended to depress live weight gain compared to a single dose of 45 mg. Everitt concluded that the results indicated re-implantation was not advantageous.

However, the introduction of zeranol renewed interest in the use of repeat implants. Implanting steers with 24 or 36 mg of zeranol, at an average weight of 85.6 kg, and re-implanting with 36 mg 84 days later resulted in faster gains after 132 days compared with control steers (Nicholson et al., 1973). However, they showed no advantages for re-implantation of zeranol over the 204 day trial. Advantages in preweaning growth of steers re-implanted with 36 mg of zeranol were also reported by Davis et al. (1984) and Ward et al. (1978). Ellington et al. (1979), however, found no significant effects on weaning weights due to implanting heifers with 36 mg of zeranol at 79 day of age or re-implanting 56 days later.

Lamm et al. (1980) indicated that when bull and heifer calves were implanted with 36 mg of zeranol every 100 days from birth to slaughter, there was no effect on gain during the postweaning growing and finishing period. However, Kunkle et al. (1980) concluded that re-implanting steers with zeranol caused an additive effect on postweaning gains.

Brethour (1980) has worked with up to three zeranol implants and found both gain and feed efficiency were improved with re-implantation. Simms (1985) reported on more than 1300 steer calves indicating an average improvement in weaning weight of 19.2 pounds for a single zeranol implant and 32.9 pounds for calves re-implanted during the suckling phase. A review of implant trials conducted in Kansas, Kentucky, and Tennessee indicated weight gain to be quite variable with responses ranging from 10 to 20 pounds per implant. On a

percentage basis, a single zeranol implant during the suckling phase increased gain 4-6% while a re-implant increased gain 8-10%.

Re-implantation may be beneficial during the growing-finishing period according to Hembry et al. (1976) who conducted implanting trials with cattle. They implanted 38 steers with 36 mg of zeranol and left 38 steers as controls (non-implanted). The steers grazed summer perennial pasture for 112 days and then were re-implanted and moved to winter annual grass for 137 days. At completion of the grazing period, part of the steers from both groups were randomly assigned and re-implanted with 36 mg zeranol for an 84-day finishing phase. Re-implanting the steers resulted in faster gains during winter grazing. Daily gains during the finishing phase were: (1) non-implant, 1.2 kg; (2) grazing implant, 1.25 kg; (3) implanted start of finishing, 1.45 kg; and (4) implanted at the beginning of all three periods, 1.41 kg. Feedlot response to implanting was reduced when steers were implanted during the grazing period. Koers et al. (1976) reported a favorable response by cattle that were re-implanted with zeranol and similar results were reported by Ward et al. (1978).

Perry et al. (1970) reported the effects of delayed implants in finishing steers and found that steers implanted with 36 mg of zeranol on day 1 and day 56 of a 156-day feeding trial gained significantly more than steers implanted only on day 1. Gill (1978) found that cattle implanted at recommended levels gained no better than those that received no implant provided they were kept on feed for 160 days without being re-implanted. He indicated that a 30 to 40 day withdrawal period will erase 30 to 80 percent of the advantages of using implants.

In contrast to some of the previously mentioned trials which supported re-implanting calves for improved growth, other researchers have not had the

same results. Nicholson et al. (1974) conducted a test to compare the effects of different levels of zeranol on growth. Calves implanted with 36 mg of zeranol at 112 d, 56 d, or 28 d intervals during a 224 d trial showed a significant increase in average daily gain when compared to a control (non-implanted) group. However, there was no significant difference in the rate of gain of calves implanted at the different intervals.

Current recommendations on the frequency of implanting cattle are that the maximum response from zeranol implants will not exceed 75 - 87 days. Hence, growing and finishing programs that exceed 120 days should include re-implanting.

Safety and Toxicity

In order to establish the safety of zeranol, a battery of toxicity tests have been done in several animal species. Results of these studies enabled International Mineral Cooperation to obtain clearance in over 40 nations for the sale of zeranol to livestock producers.

To assess the risk of an agent to humans, two things must be known: 1) the toxicity of the agent, and 2) the exposure humans have to that agent. A highly toxic agent to which humans have very limited exposure may pose little risk but, an agent with lower toxicity to which humans have a high exposure could be a hazard to health. The toxicity is then related to the residue data in a attempt to estimate risk from zeranol in the food chain.

Residue Detection

To obtain FDA clearance approval zeranol must be validated by two FDA laboratories and one Department of Agriculture laboratory. A chemical method which involves the use of gas chromatograph equipment was used to detect residues for clearance approval. This method is capable of detecting as little as 3 ng of zeranol in 100 gm of tissue which is equivalent to a sensitivity of

20 parts per billion (ppb). The method is applicable to fat, liver, kidney and tripe. There were no detected residues in edible tissue of cattle slaughtered 65 days following implanting with 36 mg zeranol, or in lambs 40 days following the implantation of 12 mg zeranol (Olsen et al., 1983).

Pellets of zeranol have been found at the site of implantation, encapsulated by fibrous tissue, 65 days after injection, with an equivalent of 10 mg of zeranol present. There was still 9 mg present 125 d following implantation (Sharp and Dryer, 1972). Similarly Hoffman and Karg (1976) reported 20% of Diethylstilbestrol (DES) could be retrieved at the implant site 119 days post-implantation. The material remaining at the site of implantation may be a source of hormonal residue as well as a source of continued release of active compounds into the animals system. It has also been stated that formation of tissue residue from exogenous compounds is a function of the rate of absorption from the site of implantation and the rate at which residues are cleared from the body. This clearance rate probably varies between compounds.

Heitzman et al. (1980) have shown that concentrations of anabolic residue in edible tissues is similar to that of the naturally occuring sex steroids. Hoffman (1980) concluded that endogenous hormones, consumed from beef carcass properly treated with implants, will not measurably influence the steroid levels in humans.

Zeranol Improves Feed Efficiency

Feed efficiency is an important trait for cattleman who are finishing or growing cattle. Cattleman routinely experience fluctuating grain prices which forces them to take a close look at feed conversion. Feed efficiency is a trait that is highly heritable (40 percent), thus improvement can be made by selection. Sharp and Dyer (1971) used 72 yearling steers, with an average

weight of 320 kg, in a 117 d trial to investigate the response to zeranol when fed rations based on milo, barley, corn or wheat. Nine steers on each ration were implanted with 36 mg of zeranol and nine served as controls ration. Feed efficiency for implanted steers fed the four rations was improved 9 percent. Nicholson et al. (1974) implanted weaning steers with 36 mg of zeranol and noted similar improvement in feed efficiency.

Nutritional and Genetic Factors

Probably the two most important factors affecting the response obtained from growth promotants are genetics and nutrition. If nutrients are adequate to allow animals to express their genetic growth potential, the effect of a growth promotant will be greater than if nutrients are limited.

Laudert et al. (1980) reported that during a 68 day winter growing period, steer calves that were at least one quarter Simmental, Limousin, or Charolais responded more favorably (9% improvement) to zeranol implants than more conventonal Hereford and Angus crossbred steers (2% improvement) when compared to similarly bred non-implanted controls. McReynolds et al. (1979) compared calves sired by Simmental cross bulls and out of Hereford cows to calves sired by Hereford bulls and out of Hereford Angus cross cows. They found that implanted calves sired by Simmental or Hereford bulls gained .73 and .71 kg per day, respectively versus gains of .70 and .64 kg for similarly sired nonimplanted controls.

Producers exert daily influence on the nutritional well being of their animals, and nutrition has been shown to be as influential as genetics in affecting responses to growth promoting implants.

Milk production of the cow, as influenced by both genetics and nutrition, plays a major role in the growth rates of the suckling calf and therefore the calf's responses to growth promotants. Hendrix et al. (1979)

studied the effect of milk production on the response of suckling calves to zeranol implants. The Purdue study used 240 spring-born calves implanted with zeranol at an average age and weight of 50 days and 79 kg, respectively. A second zeranol implant was given 80 days later. Growth response due to zeranol implantation ranged from 3.6 to 14.1 kg and was directly related to milk production of the cows.

Foster and Raleigh (1972) utilized 52 fall-born calves to evaluate creep feeding of suckling calves in combination with zeranol implants. Approximately half of the calves received creep feed for 107 days and the others received no creep feed. Half the calves in each group were implanted with 36 mg of zeranol; the other received 12 mg of DES. Responses to creep feeding and growth promoting implants was additive in this study. Zeranol and DES implanted calves that received creep feed gained 1.08 kg/day versus .84 and .87 kg/day, respectively for the non-implanted, non creep fed control calves.

Kercher et al. (1976) demonstrated the effect that advancing maturity of native range forage can have on the response of steer calves implanted with zeranol. Spring-born Angus and Hereford steer calves suckling two-year-old dams were divided into a control and two implant treatment groups for the 174 day study: Group (1) control no implant; (2) 36 mg zeranol; (3) 36 mg zeranol day one and 36 mg zeranol day 69. In all cases implanted calves out gained controls. However, growth rate declined during the summer grazing season.

Branine et al. (1981) conducted a study in which mineral supplementation was used in combination with zeranol implants. Yearling steers were selected based upon uniformity of frame and randomly assigned to one of four mineral supplemention groups for the 110 day trial. Group (1) complete mineral supplement including phosphorous and potassium, (2) complete mineral supplement, no potassium (3) complete mineral supplement only. Each group was

divided with half implanted and the others served as non implanted controls. During the early portion of the study, implanted steers gained significantly ($p<.10$) more than non-implanted controls.

There were no significant zeranol X mineral interactions, which agrees with earlier work of Ramsey (1978), weight gain in all mineral treatment groups was greater for the implanted cattle versus non-implanted steers.

Gould et al. (1982) evaluated the effects of zeranol used in combination with trace minerals for steers grazing summer pasture. During the 113 day trial, implanted steers on regular mineral gained 106.3 kg compared to 89 kg for non-implanted controls. When trace mineral added to the salt-mineral mixtures, implanted cattle gained 121.6 kg versus 107.0 kg for controls. Thus, trace mineral supplementation and implant response in this study were additive in their influence on weight gains in yearling steers.

Borger et al. (1973b) reported results from a 169 day protein and implant trial. Zeranol implanted steers gained 7.8% faster ($P<.05$) then non-implanted controls. Three dietary protein levels (9.5, 11.0 and 12.5%) were used in conjunction with zeranol. No significant differences were observed in average daily gain due to dietary protein level alone.

Implanted steers consumed 21.3% more of the 9.5% protein diet and were 4.2% less efficient (gms gain/kg feed) than non-implanted controls. In contrast, implanted steers on the 11.0 and 12.5% protein diets consumed 3.7 and 16.7% less feed and were 11.6 and 17.5% more efficient, respectively, than controls. No differences were detected between the implanted and control steers fed the 12.5% protein diet.

Effect of Maturity and Frame Type on Response to Implants

Results of Trenkle (1979a) reflect a difference in maturity according to frame type of cattle. In the first period, there was no difference between

small (Hereford and Angus) and large (3/4 and 7/8 Simmental) types of cattle with respect to feed efficiency and rate of gain. During the second period, when fat deposition made up a greater proportion of the gain of the smaller type cattle, they were less efficient and gained less than the large cattle. As the large cattle reached maturity they also became less efficient.

From a comparison of the two types of cattle, it was concluded that smaller type cattle were as efficient as larger cattle when both types were fed to similar carcass grades. The large cattle gained at a faster rate, but this was because of greater feed intake. Average quality grade of both types of cattle was choice. The larger cattle had less back fat and larger muscles.

Estradiol implants were used in the Trenkle (1979a) trial and significantly increased gain ($P<.01$). Implanted large cattle gained an additional 44 pounds, but small framed cattle responded with 70 additional pounds when compared to controls. Feed efficiency was improved 13% in the small cattle but no improvement was observed for the large cattle over the 267 day feeding period. Large cattle did not respond to implants during period one (64d.), but gained 5.6% more during period two (84d.), and 12.5% more during period three (97d.), than non-implanted large framed cattle. In the small cattle, gain was increased 18.7% during period one, 16% during period two (small framed cattle were slaughtered on day 169 of the trial). Implants were removed prior to the last weigh period, but the smaller cattle continued to gain 33% faster than controls (1.91 vs. 1.44 pounds per day). Large framed cattle, after implant removal, continued to gain 7% faster than the controls (2.58 vs. 2.42 pounds per day). Trenkle observed that it appeared large type cattle did not respond to an implant until growth rate was declining as they approached maturity.

Trenkle et al. (1979b) also reported that small early maturing cattle had higher concentrations of insulin and lower concentrations of growth hormone than large, later maturing cattle. Within each type of cattle, implanted calves had higher concentration of growth hormone. This data confirms previous studies in which estrogen has been shown to increase growth hormone concentration in blood of cattle and sheep.

The regulation of fat synthesis and degradation has been shown to be controlled by insulin. Trenkle et al. (1979b) assumed that since the small, early maturing cattle have higher concentrations of insulin in their blood and have more insulin bound to their cells, that differences in insulin, between the small and large type cattle, may contribute to the earlier fat deposition in smaller animals. The higher growth hormone concentrations and greater quantity of growth hormone bound to cell membranes in the large frame cattle may account for their greater growth and later fat deposition. Increased growth hormone concentration in cattle with estradiol implants is probably responsible for the faster rates of gain. One suggested action of the implants used for growth promotion is that they increase growth hormone production by the pituitary gland.

The influence of zeranol implants on weight gain has been extensively researched. Yet, limited information is available on what effects body type might have on weight gain when zeranol is implanted during the preweaning phase of beef production.

Table 1. OUTLINE OF EXPERIMENTAL PROTOCOL

Time Period	Activity
0 day	One hundred eight-seven steer calves (average 51 d old) were weighed and their hip ht measured. Calves were sorted by hip ht into small (85 cm and below) or large (above 85 cm) frame groups. Half of each frame group was implanted with 36 mg zeranol and the other half served as non implanted controls.
0 to 120 d	Calves were maintained with their dams in randomly assigned pastures with no supplemental feed. During this post-implant period, there were 100 calves in 1984 and 77 in 1985.
120 d	All calves were weighed, however, only the calves in 1985 were re-implanted with 36 mg zeranol.
120 to 185 d	Calves were maintained with their dams in previously assigned pastures with no supplemental feed.
185 d	Calves re-implanted in 1985 had their final wt and hip ht measurement taken then were weaned.

Materials and Methods

One hundred eighty-seven preweaned spring born (February, March and April) steer calves from the same ranch in northwest Kansas were utilized in this trial, conducted in 1984 and 1985. Table 1 gives the experimental procedure by day and activity. Calves were assigned to one of two treatments (control--non implanted) or (36 mg zeranol implant) at branding. Calves were an average of 51 d old at treatment which is designated d 0. Implants were inserted at the recommended location for zeranol, just over the ring of cartilage at the base of the ear in the "pocket" of loose skin. Sires of small frame calves were predominantly Hereford and Angus while sires of large frame calves were Beef Brown Swiss, Chianina, Limousin, Main Anjou and Simmental. Dams of all calves were either Hereford or Hereford-cross.

Individual non shrunk weights and hip heights were taken at branding on May 10, 1984 and May 2, 1985 at an average calf age of 55 and 47 d for years 1984 and 1985, respectively. All calves in each frame group had a second weight taken 120 d after implanting and weight gain was pooled for both years. In the statistical analysis, year effects were removed from the initial period performance. Calves from 1984 were unavailable after day 120. The calves during 1985 were re-implanted with 36 mg zeranol 120 d after the first implant and the weight gain was measured from then until weaning 65 d later. Final weight and hip height measurements were taken at weaning 185 d after branding only in 1985.

The following variables were calculated: weight gain 120 d post implanting (both years), weight gain 65 d post re-implanting (1985) and total weight gain 185 d post implanting (1985).

Data collected included birth date; dams age; individual weights; individual hip height measurements; and sire and dam breed.

Data were analyzed using General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 1982). The experimental design was a 2 by 2 factorial with initial weight within frame group used as a covariate. Hip height was adjusted for constant calf age using initial age as a covariate in least-squares analysis. The model included: year, frame, implant, frame and implant, age and frame. Correlation coefficients for ten traits were analyzed using the same model.

Results and Discussion

Results of implanting spring-born preweaned steer calves with zeranol are presented by frame group in Tables 2 and 3. Dams age, birth wt, initial calf age and inital wt were tested for affect on results. Initial wt was the only trait having an effect ($P<.05$), therefore initial weight used as a covariate. Least-squares means were used for weight and hip ht traits. In addition, hip ht was adjusted for constant calf age using initial age as a covariate. All traits included 1984 and 85 calves except final wt and hip ht which were for only 1985. The small frame implanted calves in (Table 2) were 1.2 cm taller (final hip ht) than comparable non-implanted controls. Large frame implanted calves were also 1.1 cm taller (Table 3) than large frame controls.

Weight gains were pooled for both years in the first 120 d post-implant period. In Table 4, the implanted small frame calves gains were greater ($P<.05$) and approached significance ($P<.10$) in large frame implanted calves when compared to non-implanted controls in Table 5. Implanting increased calf weight during the first 120 d after implanting (6.3 and 5.5 kg for small and large frame calves, respectively). Re-implanting 120 d after the first implant resulted in a non-significant 7.2 decrease in gain for the following 65 d in large frame steers. In contrast, small framed implanted steers had a 4.7 kg increase in gain as compared to their controls during the 65 d after the second implant. Simms (1985) reported a similar trend.

For the total 185 d period (1985 only), implanting resulted in 7.1 kg more gain for implanted small frame calves and 2.6 kg less for the large frame implanted calves than for their respective non-implanted controls.

Results for average daily gain are presented in Table 6 (small frame) and Table 7 (large frame). The large framed calves out gained the small frame calves in each wt gain period whether implanted or not.

Figure 1 represents a comparative summary between the small and large frame groups. The non linear equation was designed to fit a model that plotted a growth curve from the four individual weights: birth = 0 d, first implant = 51 d, 120 d wt after first implant = 171 d and final wt 65 d after second implant = 236 d.

Correlation coefficients for the ten selected traits are presented in Table 8. Highly correlated traits were wt after (2) implanting and final wt (3) ($r = .88$); starting wt (1) and final wt (3) ($r = .81$); final wt (3) and final hip height ($r = .87$) and wt (2) and starting wt (1) ($r = .89$). Correlations indicate heavier calves at first implant wt (1) were heaver at weaning 185 d later. Calves with the largest frame were also heavier at weaning. Zeranol implanted calves may have responded differently because of differences in weight, frame size and nutrition as has been previously shown by Fox and Black (1984). Nutrition can be as influential as genetics in affecting response to growth promoting implants (Foster and Raleigh, 1972). If nutrients are adequate to allow animals to express their genetic growth potential, the effect of a growth promotant will be greater than if nutrients are limited.

In this experiment hip height was used to divide calves into small and large frame groups. Large frame cattle mature later and require a higher level of nutrients than small frame cattle (Trenkle et al., 1979). Since growth and maturity occur at different rates for the various frame types, it could be postulated that the growth response to zeranol might differ between the small and large frame categories. Both frame groups responded to an implant during

the initial 120 d preweaning periods summarized from the two years data. Calves would have been younger and the quantity and quality of forage available to the cows probably provided adequate nutrition for the implant to increase growth.

The failure of large frame calves to respond to a second implant, while the small frame calves continued to growth more rapidly, suggests that the larger calves need more nutrients than their dams or the forage was able to provide. Milk production of the dam, as influenced by factors such as nutrition, can affect the growth rate of the suckling calf and alter the response to growth promotants (Hendrix et al., 1979). Dams were probably producing less milk after an early peak in their lactation cycle and the quantity of nutrients suppled by the grass decreased progressively during the summer which would be in agreement with explanations of Kercher et al. (1976).

Small frame calves responded to a greater extent to implantation than large frame calves. Since the small frame calves grew at a slower rate, their nutrient requirements for growth were lower and this apparently provided more opportunity for an implant to be effective.

These results indicated that one zeranol implant at branding (2-3 mo) is economically beneficial in terms of increased weight gain for both large and small frame steer calves. This growth advantage continues for small frame calves after a second zeranol implant and results in a heavier calf at weaning when compared to non-implanted controls. There was no advantage derived from a second implant in the large frame calves.

TABLE 2. MEANS AND STANDARD ERROR FOR SMALL FRAME CALVES

Trait	Treatment		
	Control	Implant	SE[a]
No. calves	47	46	
Dams age, yr.	4	3.6	.27
Birth wt, kg	36.4	35.8	.44
Initial calf age, d	51	57	15
Weight[b], kg			
Initial	75.5	75.2	12.6
Re-implant (120 d)[c]	192.1	198.4	2.33
Final (185 d)[c]	247.2 [d]	255.3 [e]	4.62
Hip Ht[b], cm			
Initial[e]	82.1	82.8	.74
Final (185 d)[f]	110.9 [d]	112.1 [e]	.73

[a] Standard error of the mean.

[b] Least-square means, model included: yr, frame, implant, frame* implant, age* frame.

[c] Initial weight used as a covariate.

[d] Value represents 19 observations.

[e] Value represents 20 observations.

[f] Hip height adjusted for constant calf age using initial age as a covariate in least-squares analysis.

TABLE 3. MEANS AND STANDARD ERROR FOR LARGE FRAME CALVES

Trait	Treatment		
	Control	Implant	SE[a]
No. calves	48	46	
Dams age, yr.	5.2	4.9	.22
Birth wt, kg	44.2	43	
Initial calf age, d	45	52	14
Weight[b], kg			
Initial	88.9	85.9	15
Re-implant (120 d)[c]	203.4	208.9	2.43
Final (185 d)[c]	270.7 [d]	268.1 [e]	4.77
Hip Ht[b], cm			
Initial[f]	91.1	91.5	.74
Final (185 d)[f]	117.7 [d]	118.8 [e]	.75

[a] Standard error of the mean.

[b] Least-square means, model included: yr, frame, implant, frame* implant, age* frame.

[c] Initial weights used as a covariate.

[d] Value represents 20 observations.

[e] Value represents 18 observations.

[f] Hip height adjusted for constant calf age using initial age as a covariate in least-squares analysis.

TABLE 4. EFFECT OF ZERANOL ON WEIGHT GAIN[a] IN SMALL FRAME CALVES

	Treatment		
Period	Control	Implant	SE[b]
Weight gain, kg			
Starting (0-120 d)	110.7*	117.0*	2.33
Re-implant (120-185 d)	62.1	66.8	3.8
Total (0-185 d)	165.1[c]	173.2[d]	4.62

[a] Data are least-squares means with initial wt. as a covariate.

[b] Standard error of mean.

[c] Value represents 19 observations.

[d] Value represents 20 observations.

* P<.05

TABLE 5. EFFECT OF ZERANOL ON WEIGHT GAIN[a] IN LARGE FRAME CALVES

	Treatment		
Period	Control	Implant	SE[b]
Weight gain, kg			
Starting (0-120 d)	122.[+]	127.5[+]	2.28
Re-implant (120-185 d)	77.4	70.3	3.9
Total (0-185 d)	188.6[c]	186.[d]	4.72

[a] Data are least-squares means with initial wt. as a covariate.

[b] Standard error of mean.

[c] Value represents 20 observations.

[d] Value represents 18 observations.

[+] P<.10.

TABLE 6. EFFECT OF ZERANOL ON AVERAGE DAILY GAIN[a] IN SMALL FRAME CALVES

	Treatment		
Period	Control	Implant	SE[b]
ADG, kg			
Starting (0-120 d)	.92*	.97*	.02
Re-implant (120-185 d)	.96	1.03	.06
Total (0-185 d)	.89[c]	.94[d]	.03

[a] Data are least-squares means with initial wt. as a covariate.

[b] Standard error of mean.

[c] Value represents 19 observations.

[d] Value represents 20 observations.

* P<.05

TABLE 7. EFFECT OF ZERANOL ON AVERAGE DAILY GAIN[a] IN LARGE FRAME CALVES

	Treatment		
Period	Control	Implant	SE
ADG, kg			
Starting (0-120 d)	1.02[+]	1.06[+]	.02
Re-implant (120-185 d)	1.19	1.08	.06
Total (0-185 d)	1.02[c]	1.01[d]	.03

[a] Data are least-squares means with initial wt. as a covariate.

[b] Standard error of mean.

[c] Value represents 20 observations.

[d] Value represents 18 observations.

[+] P<10.

FRAME GROUPS WEIGHT BY AGE

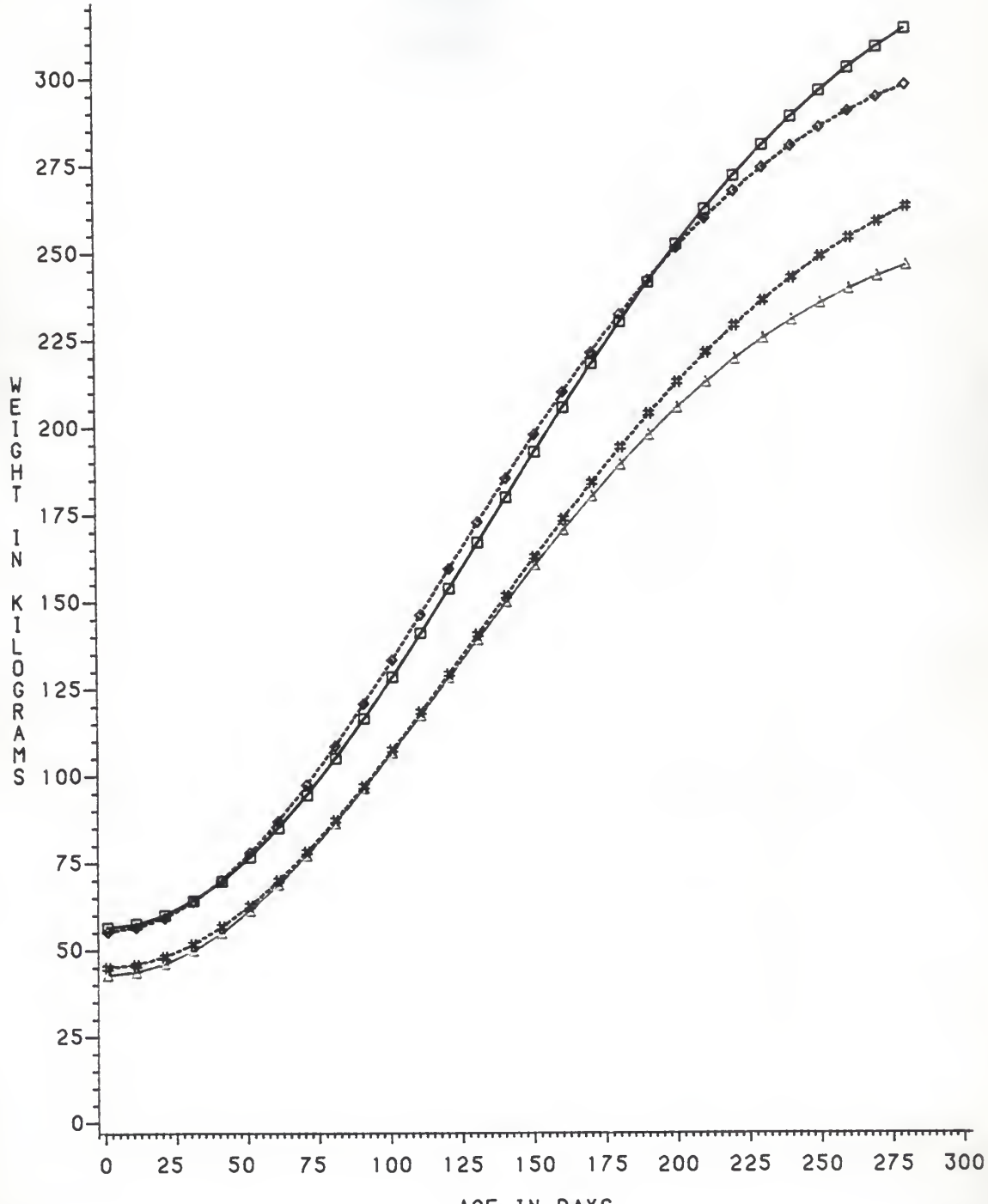

FIGURE 1

TABLE 8. CORRELATION COEFFICIENTS FOR TRAITS

TRAIT[a]	1(BW)	2	3	4	5	6	7	8	9
2 Wt1, kg	.50								
3 AGE	.18	.20							
4 Wt2, kg	.51	.79	.21						
5 Wt3, kg	.66	.81	-.16	.88					
6 Ht1, cm	.78	.77	-.19	.78	.78				
7 Ht2, cm	.71	.76	-.27	.81	.87	.89			
8 Pd1, 120d	.40	.41	.14	.89	.65	.53	.62		
9 Pd2, 65d	.45	.38	-.29	.27	.70	.40	.58	.07	
10 Pd3, 185d	.59	.53	-.26	.73	.92	.63	.78	.69	.78

[a] BW = birth wt; Wt1 = initial wt; AGE = initial calf age; Wt2 = re-implant, d120; Wt3 = final wt, d125; Ht1 = hip height, d120; Ht2 = hip height d185; Pd1 = wt gain, 120d; Pd2 = wt gain, 65d; Pd3 = final wt gain, 185d.

LITERATURE CITED

Armstrong, J. 1980. Saskatewan Agriculture. Unpublished data, personal communication.

Beverly, J. R. 1984. Ralgro--Its mode of action. International Mineral and Chemical Corp. Proc. Meeting: Implanting for Growth. pp 9-19.

Borger, M. L., J. D. Sink, L. L. Wilson, J. H. Zeigler and S. L. Davis. 1973a. Zeranol and dietary protein level effects on DNA, RNA and protein composition of three muscles and the relationship to serum insulin and GH levels in steers. J. Anim. Sci. 36:712.

Borger, M. L., L. L. Wilson, J. D. Sink, J. H. Zeigler and S. L. Davis. 1973b. Zeranol and dietary protein level effects on live performance, carcass merit certain endocrine factor and blood metabolite levels of steers. J. Anim. Sci. 36:706.

Branine, M. E., J. W. Waggoner, H. D. Radloff and S. L. Applegate. 1981. Effect of phosphorus and potassium supplement with zeranol implants at two sites on yearling steer performance. Proc. West. Sec. Am. Soc. Anim. Sci. 32:89.

Brethour, J. R. 1980. Ralgro in finishing cattle, "3 Steps Beyond Program, IMC, March - April, no. 1034.

Brown, R. G. 1980. Toxicology and tissue residues of zeranol: In "The Use, Toxicology and Residues of Growth Promoters" Conference Dublin 1980 p 31.

Brown, J. G., Bates, P. D., Holliday, M. A. and Millward, O. J. 1981. Thyroid hormones and muscle protein turn over. Biochem. J. 194, 771-781.

Brown, R. 1983. Alternate implant site shows advantage. Feedstuffs, March, p 15.

Buttery, P. J., B. G. Veron and J. T. Pearson. 1978. Anabolic agents: Some thoughts on their mode of action. Pro. Nutri. Soc. 37:311.

Cain, M. F. 1985. Beef industry growth potential. Management for Growth Conference. IMC. Orlando, Florida. p 69-95.

Corah, L. R. 1984. Review of all implants. Proc. Implanting for Growth. IMC Corp. Calgary, Alberta. Sept. 20. pp 35-40.

Corah, L. R., J. G. Riley, K. K. Kimple and M. McKee. 1976. Effect of growth-promoting implants on gains of nursing calves. KS State Univ. Cattlemans Day 1977. Agric. Exp. Sta. Rep. of Progress 291. p 13.

Corah, L. R., L. Fink, G. H. Kiracofe and M. McKee. 1979. Sexual development and carcass traits of levels after sequential implanting with zeranol. J. Anim. Sci. 49(Suppl. 1):287.

Davis, S. L., K. L. Hosner and D. L. Ohlson. 1984. Endocrine relation of growth in ruminants: In: Manipulation of growth in farm animals. (Ed.) J. F. Roche and D. O'Callaghan. Martinous Nijhoff, Boston. pp 151-183.

DeWees, W. D. 1980. Performance of cattle implanted with zeranol at different sites. Thesis for M. A. degree Univ. of Tennessee.

Ellington, E. F., R. J. Kittock, E. J. Duppong and M. K. Nielsen. 1979. Effects of zeranol implants on primigravid heifers. J. Anim. Sci. 49:278 (Abstr.).

Everitt, G. C. 1962. Implantation of oestrogenic hormones in beef cattle. Effects of winter nutritional depression following autumn implantation with hexoestrol and of reimplantation in spring. N. Z. J. Agric. Res. 5. pp 62.

Foster, L. and R. J. Raleigh. 1972. Ralgro and Stilbestrol implants for beef cattle. Oregon State Univ. Agri. Expt. Sta. Special Rpt. 352, pp 5.

Fox, D. G. and J. R. Black. 1974. A system for predicting body composition and performance of growing cattle. J. Anim. Sci. 58:725.

Gill, D. 1978. "Mis-management can erase implant benefits," Beef, April, pp 3.

Gould, R., R. Weisenburger and J. A. Basarab. 1982. Effect of trace mineral supplementation in combination with Ralgro implants on weight gain of pastured yearling steers. Can. J. Anim. Sci. 62:1265.

Heitzman, R. J. and K. H. Chan. 1974. Digestability and V-balance studies on growing heifers implanted with trembolone acetate. Br. Vet. J. 131:170.

Heitzman, R. J. and K. H. Chan. 1975. Alternations in weight gain and levels of plasma metabolites, proteins, insulin and free fatty acids following implantation of an anabolic in heifers. Br. Vet. J. 130:532.

Heitzman, R. J., K. H. Chan and I. C. Hart. 1977. Liveweight gains, blood levels of metabolites, proteins and hormones following implantation of anabolic agents of steers. Br. Vet. J. 133:62.

Heitzman, R. J., S. N Dixon and D. J. Harwood. 1980. Growth, feed efficiency and carcass residues following promoters: In "The Use, Residues and Topicology of Growth Promoters" Conference, Dublin 1980.

Hembry, F. G., C. P. Bogley and F. J. Peterson. 1976. Effect of zearaloanol during growing and finishing. J. Anim. Sci. 72:276.

Hendrix, K. S., L. A. Nelson, R. P. Lemenager and V. L. Lechtenberg. 1979. Implanting calves nursing cows with different levels of milk production. Purdue Univ. Cow-Calf Research Day, p 47.

Hoffman, B. 1980. Metabolism and measurement of residues of growth promoters: In "The Use, Residues and Topicology of Growth Promoters" Conference, Dublin 1980.

Hoffman, B. and H. Karg. 1976. Metabolic fate of anabolic agents in treated animals and residue levels in their meat: In: "Anabolic Agents in Animal Production" (Ed.) Lu and Rendel. FAO/WHO. Symp., Rome.

Horn, G. W., S. L. Armbruster, M. B. Gould and L. K. Mori. 1976. "Oh Say . . . Did you implant your suckling calves?" Oklahoma Agri. Exp. Stat. Res. Rep. P., 1976, October, 742:20:22.

Hutcheson, D. P. and R. L. Preston. 1971. Stability of diethyl--stibestrol and its effect on performance in lambs. J. Anim. Sci. 32:146.

Kercher, C. J., C. O. Schoonover and S. E. West. 1976. Ralgro implants for cattle on grass. Prog. Rpt. Coll. Agri. Univ. of Wyo. Stockmen's Homecoming Roundup, p 47.

KilKenney, J. B. and S. D. Sutherland. 1970. The use of hormone administration in commercial beef production in the U. K. Vet. Rec. 87. pp 734.

Knudson, J. F. and S. R. Max. 1980. Aromatization of androgens to estrogens mediates increased activity of glucose-6 phosphate dehydrogens in rat levator ani muscle. Endocrinol. 106:440.

Koers, W. C., J. C. Parrott, R. H. Klett and L. B. Sherrod. 1976. Implant systems for growing-finishing steers. Pro. Rpt. Texas Agric. Exp. Sta., 1976, March, 232.

Kunkle, W. E., E. C. Leffel, R. C. Hammon and L. W. Douglas. 1980. The performance of steers reimplanted with Ralgro. J. Anim. Sci. 51:164 (Abstr.).

Lamm, W. D., R. F. Kelly, W. H. McClure and J. P. Fontenot. 1980. Effect of zeranol implants in performances of suckling calves and growing-finishing bulls and heifers. J. Anim. Sci. 51 (Supp. 1):377.

Laudert, S. B., J. K. Matsushima and M. W. Wray. 1980. Effect of Ralgro on suckling, growing and finishing cattle. Beef Nutr. Res. CO State Univ. Expt. Stat. Gen. Series 999 p 11.

Machlin, L. J. 1976. Role of growth hormones in improving animal production: In: "Anabolic Agent in Animal Production" (Ed. Lu and Rendel) FAO/WNO Symp. Rome.

Martin, B. 1984. Safety of zeranol in the food chain. In Proceeding Conference: Implanting for Growth, Calgary, Alberta, Sept. 20-21, 1984, pp 21-33.

McClure, W. H., J. P. Fontenot and K. E. Webb, Jr. 1979. Ensiled corn forage and broiler litter and zeranol implant for finishing heifers. Livestock Res. Rpt. Res. Div. Rpt. 175. Virginia Polytechnic Institute and State Univ. p 69.

McReynolds, W. E., C. T. Gaskin, S. Clarke and R. L. Preston. 1979. Ralgro and Synovex-S implants for steers during the nursing, growing and finishing periods. Proc. West. Sec. Am. Soc. Anim. Sci. 30:45.

Morrow, R., A. Brooks, T. Fairbrother, R. Youngquist and D. Jacobs. 1983. Effects of implanting with Ralgro on growth and reproductive performance of beef heifers. Missouri Beef Cattle Research 1983. Animal Science Rpt. 103. p 52.

Muir, L. A. 1985. Mode of action of exogenous substances on animal growth--An overview. J. Anim. Sci. 61(Suppl. 2):154.

National Cattlemans Assoc. NCA. 1982. Special Advisory Committee Report--The Future for Beef, Beef Business Bulletin. 5-26 - 4-32.

Nelson, L. A., T. W. Perry, M. Stob and D. A. Huber. 1972. Effect of DES and Ralgro on reproduction of heifers. J. Anim. Sci. 35:250.

Nicholson, L. E., A. L. Lesperance and J. A. McCormick. 1973. Influence of interval between implants of zeranol on weight gain. Proc. West. Sec. Smer. Society Anim. Sci. 24:308.

Nicholson, L. E., A. L. Lesperance and J. A. McCormick. 1974. Effect of energy level of zeranol response. J. Anim. Sci. 38:1343-44.

Olsen, R. F., P. J. Wangsness, R. J. Martin and J. H. Gahagen. 1977. Effects of zeranol on blood metabolites and hormones in wether lambs. J. Anim. Sci. 45:1392.

Olsen, R. F., P. J. Wangsness, R. J. Martin and J. H. Gahagen. 1983. Effects of zeranol on blood metabolites and hormones in wether lambs. J. Anim. Sci. 45:1392.

Parker, J. R., W. R. Backus, H. M. Jamison and J. W. High. 1979. Results of administering various levels of Ralgro implants in yearling beef steers. TN Farm and Home Sci. Oct., Nov., Dec., 1979. p 2.

Perry, T. W., Martin Stob, D. H. Huber and R. C. Peterson. 1970. Effect of subcutaneous implantation of resorcyclic acid lactone on performance of growing and finishing beef cattle. J. Anim. Sci. 31:789.

Plegge, S. D. and L. R. Corah. 1979. Effects of location and crushing of zeranol implants on cattle performance. 71st Annual Meeting ASAS: Tucson, Abstract, pp 199.

Preston, R. L. 1975. Biological responses to oestrogen additives in meat producing cattle and lambs. J. Anim. Sci. 41:144.

Ramsey, T. S. 1978. Effects of dietary sulfur addition and Synovex-S ear implants on feedlot steers fed on all-concentrate finishing diet. J. Anim. Sci. 46:463.

Rhind, S. M., D. Zygoyiannis, J. M. Doney, I. D. Leslie and I. D. Hart. 1984. Effects of zeranol implants and dietary supplement on growth rate,

endocrine status and blood metabolite levels of growing lambs at pasture. Anim. Prod. 39, 269-276.

Riley, J. 1983. Survey of Kansas cow-calf producers. Cattlemen's Day Rpt. of Prog. 427 pp 87-88.

Rothenbacker, H., J. P. Wiggens and L. L. Wilson. 1975. Pathological changes in endocrine glands and certain other tissues of lambs implanted with the synthetic growth promotant, zeranol. Am. J. Vet. Res. 36:1313-1317.

SAS. 1982. SAS User's Guide: Basic. Statistical Analysis., Inc., Cary, NC.

Sharp, G. D. and I. A. Dyer. 1971. Effect of zearalanol on the performance and carcas composition of growing-finishing ruminants. J. Anim. Sci. 33:865.

Sharp, G. D. and I. A. Dyer. 1972. Zearalanol metabolism in steers. J. Anim. Sci. 34:176.

Simms, D. D., F. L. Schwarz and L. C. Corah. 1982. Effect of implanting with zeranol during the suckling period on subsequent reproduction and productivity in beef heifers: American and Canadian Scoiety of Ani. Sci., Joint Annual Meeting, Aug. 8-11, Guelph, Ontario, Canada. Abstract.

Simms, D. D. 1985. Ralgro implants in suckling calves and growing cattle. Management for Growth Conf. Orlando, Florida. pp 177-188.

Simms, D. D. 1986. Cowherd survey summary northwest Kansas area. KS State Univ. Unpublished data.

Thomas, O. O. and Jesse Armitage. 1970. Zearalanol for growing-fattening steers. Proc. West. Sect. Amer. Soc. Anim. Sci. 21:99.

Trenkle, A. H. 1969. The mechanisms of action of estrogens in feeds on mammalian and avian growth. In: The use of Drugs in Animal Feeds. Natl. Acad. Sci. Pub. 1679. pp 150-164.

Trenkle, A. H. 1975. The anabolic effect of estrogens on nitrogen metabolism of growing and finishing cattle and sheep: In: F. C. Lu and J. Rendel (Guest Ed.) Anabolic Agents in Animal Production. FAO/WHO Symp. Rome. pp 79-88. Geary Thieme Publ., Stuttgart.

Trenkle, A. H. 1979a. Influence of body type and Estradiol implants on growth and feed efficiency of cattle. Coop. Ext. Service. R299. Iowa State Univ. Ames.

Trenkle, A. H. 1979b. Endocrinology of Beef Cattle of different frame size and with or without estrodial implants. Coop. Ext. Service. R300. Iowa State Univ., Ames.

Trenkle, A. H. and W. Burroughs. 1978. Physiological effects of estrogens in animal feeds with emphasis on growth of ruminants. In: J. N. Natchcock and J. Coon (Ed.) Nutrition and Drug Interrelations. pp 577-611. Academic Press, New York.

Unruh, J. A., D. G. Gray, M. E. Dikeman and L. R. Corah. 1983. Effects of zeranol implantation periods on development and masculinity of young bull fed for slaughter. J. Anim. Sci. 57(Suppl. 1):412.

Ward, J. K., T. J. Klopfenstein, S. D. Farlin, L. Peterson and G. E. Schindler. 1978. Ralgro implants from birth through finishing. J. Anim. Sci. 47(Suppl. 1):43.

Wiggins, J. P., L. L. Wilson, H. Rathernbacher and S. L. Davis. 1976. Effects of dielhylstilbestrol, zeranol and sex on live blood metabolite, carcass and endocrine characteristics of lambs. J. Anim. Sci. 43:518.

Wiggins, J. P., H. Rothenbacher, L. L. Wilson, R. J. Martin, P. J. Wangsness and J. H. Ziegler. 1979. Growth and endocrine responses of lamb to zeranol implants: Effects of preimplant growth rate and breed of sire. J. Anim. Sci. 49:291.

Wyatt, R. D. 1983. Official lists advantage of new site for Ralgro implant. Beef, Sept.

APPENDIX TABLES

TABLE 1.

Dependent Variable: Starting Period (0-120d)

Source	DF	SUMS OF SQUARE	F Value	PR>F
Year	1	22089.63	99.22	.0001
Implant	1	1609.55	7.23	.0078
Frame	1	.06	0.00	.9866
Imp* Frame	1	7.99	0.44	.8501
Wtl* Frame	2	8263.72	18.56	.0001

TABLE 2.

Dependent Variable: Re-implanting Period (120-185d)

Source	DF	SUMS OF SQUARE	F Value	PR>F
Year	0	0		
Implant	1	29.66	0.12	.7285
Frame	1	341.31	1.40	.2411
Imp* Frame	1	658.75	2.70	.1049
Wtl* Frame	2	1305.71	2.67	.0760

TABLE 3.

Dependent Variable: Final Period (0-185d)

Source	DF	SUMS OF SQUARE	F Value	PR>F
Year	0	0		
Implant	1	140.43	.39	.5354
Frame	1	524.68	1.45	.2326
Imp* Frame	1	540.56	1.49	.2257
Wtl* Frame	2	4008.67	5.54	.0058

EFFECTS OF ZERANOL IMPLANTS ON WEIGHT GAIN IN LARGE AND SMALL FRAME PREWEANING STEER CALVES

by

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ABSTRACT

One hundred eighty-seven preweaned steer calves were used to evaluate the influence of zeranol implants on body weights gain (WG) in small (S) and large (L) frame beef cattle. At branding (average 51 d), calves were sorted according to hip ht measurement into S (average 82 cm) or L (average 91 cm) frame groups and randomly assigned to a non-implanted control (C); or to a 36 mg zeranol implant (I) group. Two years data (1984 and 1985) were combined for the trial which began at implanting and continued until weaning. Hip height and weight gain of all calves was determined at 120 d after implanting, however, only the calves (77) in 1985 were re-implant. They were weighed and measured again 65 d after the second implant. Calves were maintained with their dam on short grass pasture with no supplement. During the initial 120 d period, WG was greater ($P<.05$) for SI and approached significance ($P<.10$) in LI when compared to C. A second implant given at the end of the 120 d initial period produced a non-significant increase in growth within the small frame group during the subsequent 65 d period; however, large frame calves given a second implant gained less than the non-implanted controls. Weight gain for the entire 185 d was not significantly different within either the small or large frame calves. Large frame calves gained more weight during each trial period than those that were small framed but zeranol implants were more beneficial in small frame calves.

Frame Groups:	No of. Steers	Small		Large	
Treatment:		Control	Implant	Control	Implant
Period:					
0-120 d gain, kg	187	110.7*	117.0*	122^{+}	27.5^{+}
120-185 d gain, kg	77	62.1	66.8	77.4	70.3
0-185 d gain, kg	77	165.1	173.2	188.6	186.0

*$P<.05$

$^{+}P<.10$

(Key Words: Zeranol Implants, Body Type, Preweaning, Weight Gain)